

**UNITED STATES DEPARTMENT OF COMMERCE****United States Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
-----------------	-------------	----------------------	---------------------

09/116,138 07/15/98 ANTHONY

J TI-24953

023494 MM91/0509
TEXAS INSTRUMENTS INCORPORATED
P O BOX 655474, M/S 3999
DALLAS TX 75265

EXAMINER

MAI, A

ART UNIT

PAPER NUMBER

2814

DATE MAILED:

05/09/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trad marks

Office Action Summary

Application No.

09/116,138

Applicant(s)

ANTHONY ET AL.

Examiner

Anh D. Mai

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 February 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-30 and 36-45 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9, 12-15, 24, 25 and 36-42 is/are rejected.
- 7) ☒ Claim(s) 10, 11, 16-23, 26-30 and 43-45 is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 18) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☒ Other: *reason for allowance*.

DETAILED ACTION

1. In view of the Appeal Brief filed on February 20, 2001, PROSECUTION IS HEREBY REOPENED. The action on merit is set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

- (a) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office action is final); or,
- (b) request reinstatement of the appeal.

If reinstatement of the appeal is requested, such request must be accompanied by a supplemental appeal brief, but no new amendments, affidavits (37 CFR 1.130, 1.131 or 1.132) or other evidence are permitted. See 37 CFR 1.193(b)(2).

Specification

2. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

3. An update of the related applications on page 1 is requested.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Art Unit: 2814

4. Claims 3 and 13 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The limitation of claim 3 includes: further comprising oxidizing less than 1 nm of the clean Si surface prior to the depositing a first metal step.

However, it is well known in the art that refractory metal do not enter into any significant reaction with silicon oxide.

✂ How can metal silicide or metal silicate is formed when metal does not react to silicon oxide?

The limitation of claim 13 includes: "wherein the substrate comprises an oxidized silicon surface layer immediately prior to the deposition step".

It is known that metal deposits in an oxidizing ambient result in a metal oxide and the metal, as discussed above, hardly react to the silicon oxide.

Can metal oxide react with silicon oxide to form metal silicate?

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 4-7 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Art Unit: 2814

- a. Claim 4 recites the limitation "wherein the oxidizing step comprises simultaneous exposure of the layer of a silicide of the first metal to *both* oxidizing gas and a reducing gas" in line 1-2. There is insufficient antecedent basis for this limitation in the claim.
- b. Claims 6 and 7 recites the limitation "the reducing gas is selected from the group consisting of CO, H₂, CH₃, and combination thereof" in line 1-2 and 3-4, respectively. There is insufficient antecedent basis for this limitation in the claim.
- c. Claim 9 recites the limitation "wherein the *oxygen plasma* is exposed to ultraviolet radiation" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

6. Claims 1 and 36-41 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Hsieh et al. (U.S. Patent No. 4,432,035).

Hsieh teaches a method of fabricating a field-effect device on an integrate circuit as claimed including:

providing a single-crystal substrate (10);

Art Unit: 2814

forming a metal silicate dielectric layer (12) on the substrate; and
forming a conductive gate (14) overlying the metal silicate dielectric layer. (See Fig. 2).

With respect to claims 36-40, insofar as the final structure is concerned, the device is formed.

With respect to claim 41, the metal silicate dielectric (12) of Hsieh includes zirconium silicate dielectric.

7. Claims 1-3 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Thakur et al. (U.S. Patent No. 5,686,748).

Thakur teaches a method of fabricating a field-effect device on an integrate circuit as claimed including:

providing a single-crystal substrate (60);
forming a metal silicate dielectric layer (65) on the substrate; and
forming a conductive gate (66) overlying the metal silicate dielectric layer. (See Fig. 7).

With respect to claim 2, the forming the metal silicate dielectric layer (65) of Thakur includes:

exposing a clean Si surface on the substrate;
depositing a first metal on the Si surface;
annealing the substrate in an inert ambient, thereby forming a layer of silicide of the first metal on the substrate;

oxidizing the layer of silicide of the first metal, thereby forming the metal silicate dielectric layer (65).

With respect to claim 3, as best understood by examiner, the substrate of Thakur further comprising a native oxide (4) on the Si surface prior to the depositing the first metal step. It is known that the native oxide is about 2 nm or less. Further, the thickness of the "oxidizing" does not appear to be critical.

Further, given the teaching of the reference, it would have been obvious to determine the optimum thickness of the oxide layer. See *In re Aller*, Lacey and Hall (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation."

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 2 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh '035 as applied to claim 1 above, and further in view of Wolf et al. "Silicon Processing".

Hsieh teaches all of the features of the claim with the exception of an alternate method of forming the metal silicate dielectric by forming a metal layer on the substrate then reacting the metal with the substrate to form metal silicide prior to oxidizing to form metal silicate layer.

However, Wolf teaches various method of forming a metal silicide including:

Art Unit: 2814

exposing a single-crystal silicon substrate;
depositing a first metal on the Si surface;
annealing the substrate in an inert ambient, thereby forming a layer of a silicide of the first metal on the substrate.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to form the metal silicide of Hsieh by reacting the deposited metal with the silicon substrate as taught by Wolf to form the metal silicide (12) prior to oxidizing.

With respect to claim 42, the first metal of Hsieh is zirconium.

9. Claims 4-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Thakur '748 as applied to claim 2 above, and further in view of Leas (U.S. Patent No. 4,147,615).

With respect to claim 4, Thakur teaches all of the features of the claim with the exception of simultaneously exposes the silicide of the first metal to both oxidizing gas and reducing gas.

However, Leas teaches oxidizing a metal silicide has been performed by simultaneously exposing to both oxidation gas and reducing gas.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to expose the metal silicide of Thakur to both oxidation gas and reducing gas as taught by Leas to convert metal silicide to metal silicate dielectric.

With respect to claim 5, the oxidizing gas of Thakur is selected from the group as claimed.

Art Unit: 2814

With respect to claim 6, the reducing gas of Leas comprises a reducing gas selected from the group as claimed.

With respect to claim 7, the oxidation gas and reducing gas of Leas comprises gaseous selected from the group as claimed.

10. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Thakur '748 as applied to claim 2 above, and further in view of Hasegawa (U.S. Patent No. 5,677,015).

With respect to claim 8, Thakur teaches all of the features of the claim with the exception of oxidizing the metal silicide by exposing the silicide layer to oxygen plasma.

However, Hasegawa teaches one of the many oxidation process comprises exposing a layer to oxygen plasma.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to oxidizing the metal silicide layer of Thakur by exposing to oxygen plasma as taught by Hasegawa because oxygen plasma can be performed at low temperature, thus more economical.

With respect to claim 9, as best understood by examiner, the oxidation process of Hasegawa comprises ultraviolet radiation.

11. Claims 12-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Thakur '748 as applied to claim 1 above, and further in view of Hasegawa '015.

Art Unit: 2814

Thakur teaches all of the features of the claim with the exception of depositing the first metal on the substrate in an oxidizing ambient prior to annealing the substrate in oxidizing ambient.

However, Hasegawa teaches that a metal can be deposit in O₂ ambient to form a partially oxidized metal. (See col. 1, 46-48).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to deposit the metal of Thakur in oxidizing ambient as taught by Hasegawa to form a partially oxidized metal prior to oxidizing the substrate to simplify the process.

With respect to claim 13, the substrate of Thakur includes a native oxide layer prior to the deposition thus it meets the limitation.

With respect to claim 14, the substrate of Thakur comprises a clean Si surface immediately prior to the deposition step.

With respect to claim 15, one of the deposition process of Hasegawa comprises plasma-assisted in oxidizing ambient, hence sputtering.

12. Claims 24- are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh '035.

Hsieh teaches forming a metal silicate dielectric layer including:

evaporating an intermediate layer of material onto the substrate, the material selected from the group consisting of silicon, a first metal, and combination thereof, the intermediate layer having a thickness; and

Art Unit: 2814

annealing the substrate in an oxidizing ambient, thereby at least partially oxidizing the intermediate layer.

With respect to repeated steps, Hsieh disclose the claim invention except for repeating steps of evaporating and oxidizing.

However, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to form one thick layer of silicon and first metal or many thin layer of the same material, since it has been held that mere duplication of the essential working parts of a device involve only routine skill in the art. *St. Regis Paper Co. v. Bemis Co.*, 193 USPQ 8.

With respect to claim to the thickness of the intermediate layer, the intermediate layer of Hsieh having a thickness of 5 to 50 nm after the oxidizing. The thickness of 1 nm does not appear to be critical.

Therefore, given the teaching of the reference, it would have been obvious to one having ordinary skill in the art at the time of the invention to determine the optimum thickness of the intermediate layer. See *In re Aller*, Lacey and Hall (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation."

With respect to claim 25, the repeating step has been discussed above.

Allowable Subject Matter

13. Claims 10, 11, 16-23, 26-30 and 43-45 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is an examiner's statement of reasons for allowance: prior art of record fails to teaches a method of forming a field-effect device on an integrated circuit including: crystallizing the metal silicate layer in non-oxidizing environment or forming a partially oxidized metal silicate by depositing the metal and silicon on the substrate in an oxidizing ambient.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

14. Applicant's arguments with respect to all claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (703) 305-0575. The examiner can normally be reached on 8:30AM-5:00PM.

Art Unit: 2814

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

A.M
May 5, 2001


Olik Chaudhuri
Supervisory Patent Examiner
Technology Center 2800